

Direct Downwind Faster Than The Wind (DDWFTTW) Cart

By “spork” & “ThinAirDesigns”
(with key design concepts shamelessly stolen from “Mark C”)



This simple cart is powered by the wind, and will go directly downwind faster than the wind. It's a real mind-bender, but it's does not represent any kind of scientific breakthrough. It's doesn't represent perpetual motion and it won't make anyone millions or solve our energy problems. But it's fun to see this thing advance on a running treadmill, and even more fun to try and understand how it works.

The following is a very brief cut at a build document. I will update this document with much better descriptions shortly.

Parts List

- 4.15 Century Tail Gear Set Hawk (Tower LXMJX7)
- 6.95 Century Tail Gearbox Hawk Pro (Tower LXLKD0)
- 2.00 5x13x4 Revolution (2 front prop shaft bearings) (Avid 695-RSZ)
- 3.00 5x11x4 Revolution (2 axle bearings & 1 rear prop-shaft bearing) (Avid MR115-RSZZ)
- 3.50 Prop GWS 15x7.5 Propeller (6 for \$21.00) (Tower LXHHZ1)
- 1.75 GWS 3.00" Wheels (2 for \$1.75) (Tower LXHHZ8)
- 7.00 5mm x 40" Carbon tube for prop shaft and axle (AeroMicro)
- 0.40 4mm x 40" Carbon tube (40" for \$4.00) (AeroMicro)
2 pieces at 2" used for axle step-down
- 0.40 3mm x 40" Carbon tube (40" for \$4.00) (AeroMicro)
2 pieces at 2" used for axle step-down
- 0.10 0.08" Music wire (2 pieces at 2" used for axle step down) (Tower LXWV01) (9.99 for 15 pieces at 36" each)
- 0.02 1.25" of 0.063" Music wire for rear axle (Tower LXWV00) (9.69 for 15 pieces at 36" each)
- 2.00 3/8" soft aluminum tube (24") from plumbing dept at OSH
- 1.50 Dubro 2" Micro Lite wheels; 2 for \$2.99 (Tower: LXAZC6)
- ??? Nuts and bolts (6-32 x 1.25") to hold aluminum tube to gearbox
- ??? HDPE Bearing block to support rear prop-shaft bearing (Tap Plastics)
- ??? C/A (super glue)

+ Tax & shipping

Suppliers:

- www.towerhobbies.com
- www.AvidRC.com
- www.AeroMicro.com
- OSH: Orchard Supply Hardware

Alternate parts:

- GWS 14x10 Propeller (6 pack) (Tower LXHHY8)
- GWS 14x7 Propeller (6 pack) (Tower LXHHY9)
- GWS 3.35" Wheels with rubber tire (Tower LXHHZ4) \$3.75

NOTE:

Before you begin assembly you should **carefully** remove the bearing seals from both sides of the bearings with a jewelers slotted screwdriver, and then soak the bearings in turpentine to remove the factory grease. This reduces the bearing drag for low-load operation.



Rear end of prop shaft with guide bearing

NOTES:

- Make sure the 5x11x4 bearing fits snugly on the prop-shaft. You can build the shaft up with a thin coat of C/A or sand it down with some #600 sand paper as needed.
- When it's done properly, the bearing should be able to slide on the shaft – but not easily.



Tail end – showing aluminum “frame” going into HDPE bearing block

NOTES:

- The rear-end prop-shaft bearing block is made from a piece of ½” HDPE plastic from Tap Plastics.
- You will need to drill an 11MM hole all the way through it to accommodate the prop-shaft bearing, and another hole in the bottom to snugly accommodate the 3/8” aluminum frame piece.



End of front axle with “step down’s”

NOTES:

- The axle is made from a 5mm carbon tube.
- The ends of the axle need “step-downs” to accommodate the specified wheels. The step downs consist of a 2” piece of 4mm carbon tube inserted into the axle until the ends are flush. Cover it with C/A or epoxy before inserting it. Remove excess C/A or epoxy before it cures.
- Inside the 4mm carbon tube, we use a 2” piece of 3” carbon tube. Insert and glue this in the same way, but allow it to extend about ¼” past the end of the 5mm tube. This will serve as the axle if you decide to try larger wheels at some point.
- Finally, insert a 2” piece of 0.08” music wire, again allowing it to extend beyond the 3mm carbon tube. This is glued in the same way. This will serve as the axle for the wheels specified in the parts list above.
- Wheels may need a touch of C/A to keep them from slipping on axle.



One Half of gear box with 5x11x4 bearing inserted

NOTES:

- The 5x11x4 bearings will fit nice and snug into the gear box sides right out of the bag.
- Do not install the bearings until all the drilling and cutting is done. Any particles in the bearings will cause significant drag and may cause the cart not to operate as designed.
- Both bevel gears have a small shoulder on the non-tooth side. We sand these shoulders off to give a looser gear mesh.



Front end of Prop-Shaft with two 5x13x4 bearings and large bevel gear



Axle with small bevel gear

Notes:

- Do not do any drilling near any of the bearings. Remove all carbon dust before installing bearings. Carbon dust will foul the bearings.
- Take care not to damage any of the teeth on the bevel gears. They are soft nylon, and MUST spin VERY freely.
- Slide small bevel gear onto axle so that narrow end of teeth end up right in the middle of the axle
- Drill a small hole right through the existing hold in the bevel gear and into the 5mm carbon shaft. A Dremmel tool is very handy for this.
- Stick the provided pin through the bevel gear and into the new hole in the axle.
- With the pin holding the gear in place, turn the axle 180 degrees and drill the other side in the same way.
- Push the pin all the way through so it does not extend beyond the shoulder of the gear on either side. A pair of long nose pliers are very handy for this.

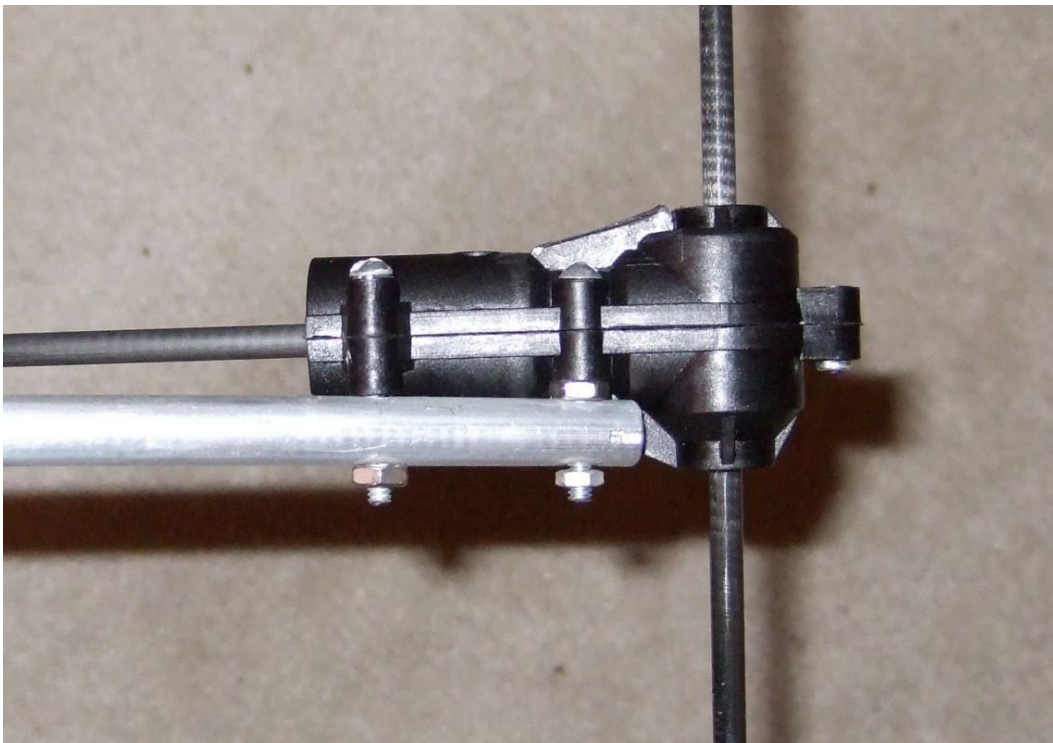


Notes:

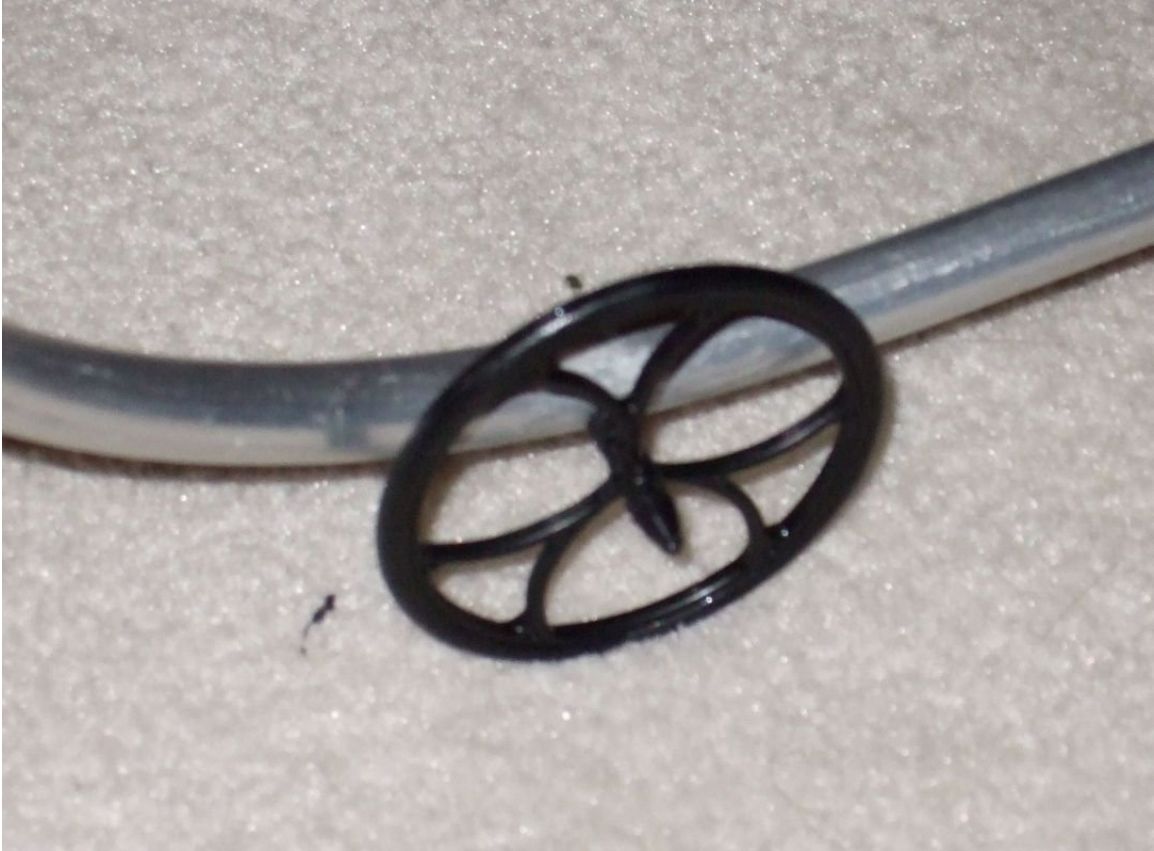
- The gear-box halves are not exactly symmetric. Be sure and place the small bevel gear in the deeper gear-box half.
- Coat the 5mm prop shaft with a thin coat of C/A (cyano-acrylate / super-glue) where the bearings will fit on. This will make the bearing fit very snug on the prop shaft. This is important so that thrust loads don't cause the gear mesh to become too tight.
- If the fit of the bearings on the prop shaft is too tight, use a piece of #600 sandpaper to reduce the prop-shaft diameter until you get a snug fit.



Front End – showing frame mounting to gear-box



Front End Bottom View – showing frame mounting to gear-box



Tail Wheel detail

NOTES:

- To mount the tail wheel, drill a small horizontal hole in the aluminum frame just big enough to accommodate the 0.063" music wire axle.
- Cut the end off one of the two provided wheel retainers and drill it all way through.
- Slide the cut wheel retainer over the axle. Then slide the wheel on, and slide the other wheel retainer over the end of the axle to capture the wheel. Make sure the two retainers are not pinching the wheel.
- Now insert the music wire into the holes in the frame and secure with a drop of C/A



Front end – showing axle, wheels, prop-shaft, gear-box, and aluminum “frame”

NOTES:

- Place the HDPE bearing block over the prop-shaft bearing and then slide it onto the top of the 3/8” aluminum frame.
- It’s important to bend the frame carefully before fitting the HDPE block on top so that it fits on the aluminum frame without putting any load on the prop-shaft.
- Drill the prop hub out with a 5mm bit and press the prop onto the rear of the prop-shaft.
- Place the wheels onto the music wire extensions on the ends of the 5mm carbon axle. You may need a drop of C/A on each to prevent them from spinning freely on the music wire.
- Start treadmill dead-level initially (we needed phone books under the rear end of ours).
- Run the treadmill at full speed (10 mph in our case).
- Hold the cart by the gear box while you lower it onto the moving belt. Don’t release it until the wheels have made good contact and the prop has come up to speed.
- Release the cart and notice what direction it moves in. It will likely veer to the left or right. To fix this, very carefully bend the aluminum frame to the left or right to change the steering of the tail-wheel. Be sure not to create

load on the prop-shaft bearing during this process. You may want to pull the HDPE bearing block off the frame occasionally to check alignment.